S Los Alamos
NATIONAL LABORATORY
Los Alamos, New Mexico 87545

public information group
news release

CONTACT: James E. Rickman, (505)665-9203 or (505)667-7000 96-200

EMBARGOED Until Tuesday, Dec. 17, at 8:30 a.m. PST
AGU Session H21B-8, Moscone Center Hall D

IN A MICROSCOPIC WORLD, LOS ALAMOS RESEARCHERS ASK, "WHAT'S EATING YOU?"

SAN FRANCISCO, Dec. 17, 1996 — Los Alamos National Laboratory researcher Bryan Travis is using computers to model the interaction between soil microorganisms and pollutants, and it's a jungle down there — even on a microscopic level there's a fine balance between the hunter and the hunted.

Today at the American Geophysical Union's Fall Meeting in San Francisco, Travis, a researcher in Los Alamos' Geoanalysis Group, presented information about how microbial predators can affect environmental cleanup activities.

"Everyone knows that certain bacteria can essentially 'eat' soil contaminants like spilled hydrocarbons, and this is useful for certain environmental cleanup activities," Travis said. "A number of computer models have been designed to help scientists understand this process.

"But traditionally these computer models haven't included how microbial predators can attack and feast on contaminant-eating microorganisms and possibly prevent them from doing their job effectively. My colleagues and I are working to make subsurface flow models that are as close as possible to reality — and the reality is that there's a community of organisms in the soil and they're all competing for resources," he said.

Travis and his colleagues have been using computers to model the flow and transport of fluids through porous media like soils, applying numerical models to real-life problems. In one application, these models can show how contaminants such as diesel fuel, gasoline, dry-cleaning solvents or other hydrocarbons travel through soil after a spill.

In other applications suited for environmental remediation activities, computer models show how water or air can most effectively be pumped into the ground to entrain contaminants and move them above ground, where the air or water can be treated to remove the contaminants.

But the process works more quickly if something — in this case bacteria — can help break down contaminants.

“In any soil sample there are hundreds, if not thousands, of species of bacteria,” Travis said, “and, frequently, among all these species, there will be at least one type that will feed on a particular contaminant, metabolize it, and produce harmless byproducts such as carbon dioxide and water.”

At the Department of Energy’s Savannah River Site, Travis and Los Alamos researcher Nina Rosenberg took the traditional fluid transport model a step further. Using a computer code called TRAMPP, they modeled air flow into the soil as well as a flow of methane and nutrients — nitrogen and phosphates — to help stimulate naturally occurring bacteria that would feast upon the methane/nutrient material and produce an enzyme called methane monooxygenase, which helps degrade trichloroethylene, a common solvent and contaminant, in the soil.

Travis and his colleagues used the model to compare several methods for feeding the bacteria. If too many nutrients were added to the system, the bacteria would thrive at an explosive rate near the injection wells, resulting in clogged soil pores — through which gases must flow — or consumption of the nutrient solution before it could diffuse through the soil to the contaminated area. If too few nutrients were added, the bacteria would die off.

In the Savannah River demonstration, Travis successfully developed a method for delivering nutrients in pulses to achieve optimum results. Actual remediation activities based on the model showed that the TRAMPP code was valid. Tests at the site also showed that by using bacteria in concert with traditional remediation techniques, the cleanup rate increased by nearly 40 percent when compared to traditional techniques alone.

But Travis realized there was more happening than simply feeding one type of bacteria. Bioremediation often works well under laboratory conditions, but sometimes isn’t nearly as effective in the field. Why?

“The soil is filled with microorganisms,” said Travis. “It’s really a jungle down there in the soil. You have these bacteria eating contaminants, but there’s also single-celled protozoa such as amoebas lurking in the area, looking for bacteria to eat. There are lots of different species of microbes that are going through the area trying to kill off other competing species.”

"WHAT'S EATING YOU?"

PAGE 3:

Travis has added non-linear aspects of microbial predator behavior into his model and, in the computer world at least, is starting to gain a "virtual" understanding of complex predator/prey interactions. In this cyber-soil environment, protozoan predator populations increase as the number of contaminant-eating microbes increases, changing the dynamics of the system.

He now is collaborating with Laura Vanderberg-Twary of Los Alamos' Waste Treatment and Minimization Science and Technology Group to validate the new model using an array of different microbes. Vanderberg-Twary tests contaminated soils in a laboratory setting to see whether contaminant levels, microbe populations and remediation results are similar to those predicted by the model.

In addition, Travis' model takes into account the fact that particles and pores in soils aren't uniform in size and shape, something neglected by other models. By taking into account this soil heterogeneity, Travis can better understand pore channels which provide mobility for gases, liquids, microbial predators and microbial prey.

"We've taken a state-of-the-art flow and transport model and have added microbial ecology so that we get a nice three-dimensional model that is as realistic as possible," Travis said. "The next step is to validate our work on a larger scale, out in the field."

Los Alamos National Laboratory is operated by the University of California for the U.S. Department of Energy.

-30-